AD-A264 994

...UMENTATION PAGE

Form Approved OMB No. 0704-0188

...ted to average 1 hour per response, including the time for reviewing ... collection of information. Send comments regarding this burden estimate ... Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA ... to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE March 1993	3. REPORT TYPE AND DATES COVERED Professional Paper
4. TITLE AND SUBTITLE CONTINUED EFFORTS ON THE UNDERWATER SECURITY VEHICLE 6. AUTHOR(S) B. E. Fletcher		5. FUNDING NUMBERS PR: MM38 PE: 0603228D WU: DN300066
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Command, Control and Ocean Surveillance Center (NCCOSC) RDT&E Division San Diego, CA 92152-5001		8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Naval Command, Control and Ocean Surveillance Center (NCCOSC) RDT&E Division San Diego, CA 92152-5001		10. SPONSORING/MONITORING AGENCY REPORT NUMBER
11. SUPPLEMENTARY NOTES		
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.		12b. DISTRIBUTION CODE

DTIC ELECTE MAY 27 1993 S A D

13. ABSTRACT (Maximum 200 words)

Remotely operated vehicles (ROVs) can play a variety of roles in the protection of marine assets against waterborne threats. The Underwater Security Vehicle (USV) program, sponsored by the Defense Nuclear Agency, was developed as an assessment tool to complement other security systems. The demonstration system, a Benthos Super SeaROVER vehicle equipped with a Smiths Hi-Scan 600 sonar, was successfully used to acquire, track, and intercept diver targets in 1991. Efforts in 1992 included expanding the detection capacity of the vehicle and the addition of non-damaging response techniques. Current efforts involve the integration of sensor and vehicle displays to permit operation of the system by a single operator.

93 5 26 082

93-11919

Published in *Underwater Intervention '93*, pp 8–14.

14. SUBJECT TERMS			15. NUMBER OF PAGES
security marine sonar systems	technology survey waterside security		16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED	18. SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED	19. SECURITY CLASSIFICATION OF ABSTRACT UNCLASSIFIED	20. LIMITATION OF ABSTRACT SAME AS REPORT

UNDERWATER INTERVENTION '93

January 18-21, 1993
New Orleans Hilton Riverside & Towers
New Orleans, Louisiana

Sponsored by

The ROV Committee of the Marine Technology Society
The 11th Annual ROV Conference & Exposition

The Association of Diving Contractors
The 21st Annual Diving Symposium

CONTINUED EFFORTS ON THE UNDERWATER SECURITY VEHICLE

Barbara E. Fletcher
Naval Command, Control and Ocean Surveillance Center
Research, Development, Test and Evaluation Division
San Diego, CA 92152 U.S.A.

ABSTRACT

Remotely operated vehicles (ROVs) can play a variety of roles in the protection of marine assets against waterborne threats. The Underwater Security Vehicle program, sponsored by the Defense Nuclear Agency, was developed as an assessment tool to complement other security systems. The demonstration system, a Benthos Super SeaROVER vehicle equipped with a Smiths Hi-Scan 600 sonar, was successfully used to acquire, track, and intercept designated diver targets in 1991. Efforts in 1992 included expanding the detection capacity of the vehicle and the addition of non-damaging response techniques. Current efforts involve the integration of sensor and vehicle displays to permit operation of the system by a single operator.

1.0 INTRODUCTION

1.1 Need

Security systems are required to protect against underwater threats to critical waterside or waterborne assets such as weapon depots, loading areas, power plants, ships, and submarines. Threats may take the form of swimmers, scuba divers, and swimmer delivery vehicles. A complete security system will address the need to detect, assess, and respond to these threats. A ROV can serve to meet these needs, alone or in concert with other security systems, without exposing humans to hazardous conditions or routine, repetitive tasks.

1.2 Objective

The objective of the Underwater Security Vehicle (USV) program (1989-1991) was to evaluate the feasibility of using an underwater ROV system to assess diver-like contacts in a near shore environment (figure 1). The follow-on 1992 effort served to enhance the system with additional sensors for detection and assessment, and the addition of a non-lethal response capability.

1.3 Approach

By direction of the program sponsor at the Defense Nuclear Agency, the USV was developed as an assessment adjunct to the Waterside Security System. Existing systems were evaluated, and a demonstration system was procured based on a commercially available vehicle and sensors. The system was tested and evaluated under a range of pierside security conditions. Based on the results of these tests, additional sensors were added to the system to expand its capabilities, and the enhanced system was evaluated in late 1992. Various methods of

Figure 1: **Vehicle Operation Showing Intercepted Target**

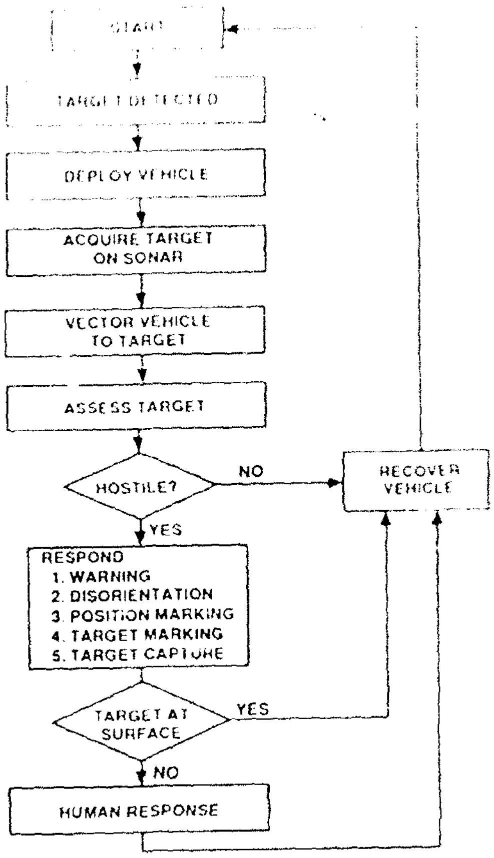

Figure 2: Mode of Operation

target response were also installed on the vehicle and evaluated as to their effectiveness in deterring and delaying a target.

1.4 Mission Description

The enhanced USV system concept (figure 2), shows how the vehicle would be used to respond to a target detected by another system. Once a contact is made by the detection sensors, the USV will be taken out and deployed at the contact location. The operator will reacquire the target on the vehicle sonar, and use the information to vector the vehicle into visual contact range of the target. Video and sonar information from the USV will be used by the operator to assess the target. If the target is determined to be hostile, the operator has a choice of response techniques available on the vehicle for immediate use.

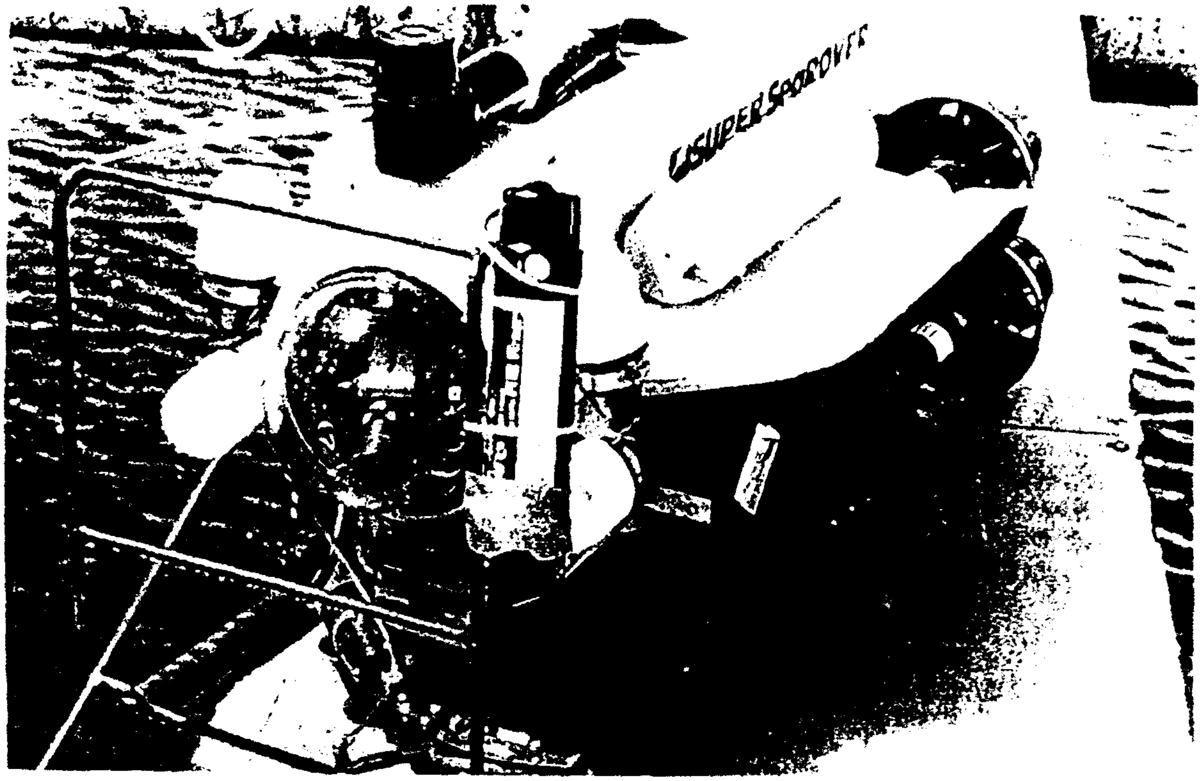

Figure 3: **The Enhanced USV Vehicle**

2.0 *UNDERWATER SECURITY VEHICLE (USV)*

2.1 USV System Description

A specification was developed for the original USV Proof of Concept System based on the mission requirements and available systems. The system procured was the Benthos Super SeaROVER vehicle with the Smiths Hi-Scan 600 sonar. This sonar was considered the best choice of the sonars evaluated for the USV system due to its high scan rate (8/second), clear display, high resolution, and ease of use under the required dynamic operating conditions. Later enhancement of the system included the addition of a small sonar, an Articulator mini manipulator, and a diver communication system (figure 3).

2.2 USV Test and Evaluation

To evaluate the feasibility of using the USV for underwater target assessment, tests were run to determine the ability to use the vehicle system to reacquire, track, and intercept a diver-like target. Based on the results of these tests, it was determined that the best operating position for the USV was in the midwater position to achieve the maximum detection range for the full range of targets. In deep water, the vehicle should be operated in the midrange of where the target is expected (ie: surface to 100').

The second series of tests determined the ability to track different target behaviors such as speed and path. The target divers were given a variety of paths to swim, including straight compass courses, dog legs, varying depths, near bottom, erratic patterns, and full-on evasive maneuvers. During formal testing 15 different runs were made, with visual target contact accomplished 11 times, a 73% success rate overall.

2.3 USV Proof of Concept

In addition to the tests described above, the capabilities of the USV system were demonstrated during a Coast Guard harbor defense exercise in August 1991. The USV was used to detect, track, and intercept two Navy SEAL diver targets at night, in low-visibility harbor conditions. The targets were tracked by the sonar and the use of upward pointing vehicle lights enabled surface personnel to locate the targets. While no visual contact was made with the vehicle camera, it was clear by the sonar tracks that the targets were of interest, providing a useful level of assessment.

2.4 USV Operational Observations

In the low-visibility harbor environment, it was found that video was of little use until the target was closely approached, generally within 1 meter. No improvement of video cameras can produce a picture at a range beyond that of the water visibility. This points up the absolute necessity of having a sonar suited to the desired application.

The high update rate of the Smiths Hi Scan 600 sonar proved to be invaluable for tracking moving targets while based on a moving platform. The high resolution allowed for the acquisition of diver-like targets and their subsequent tracking and interception. Two major difficulties were found: one, the narrow field of view (30 degrees horizontal and 10 degrees vertical) made following erratic path changes difficult, particularly at close range; and two, it was very easy to overshoot a target, particularly if it was above the vehicle operating depth.

3.0 1992 EFFORTS

3.1 System Enhancement

The USV system fills but one portion of the need for the detection, assessment, and response to underwater threats. During the USV testing, it became apparent that the vehicle could provide additional capabilities beyond the interception and assessment of underwater targets. A limited target detection capability could be provided by an additional sonar with a wider field of view and longer range, supplementing the tracking capability of the Smiths sonar. The target could be detected initially by the additional sonar, giving the operator the proper bearing to direct the vehicle. Once the vehicle is pointed in the correct direction, the Smiths sonar would be used to track and intercept. Similarly, if the target is overshot, the additional sonar can be used to determine the proper bearing for a return. A Tritech ST325 sonar with a potential 360 degree field of view and 100 yard range was procured for evaluation in this role.

In addition to the sonar, an CRE Trackpoint II system was obtained to further enhance the USV system. This system was used with the vehicle during the initial operator training, vividly illustrating the need for knowing where the vehicle is relative to the host platform. The addition of a tracking system greatly extended the USV utility and ease of use.

3.2 Response Techniques

The third function of a security system is response to a perceived threat. As the USV will be at the site of the threat for assessment, this capability was a logical next step for development. A variety of responses were investigated, falling into five main categories: warning, disorientation/irritation, position marking, target marking, and target capture. Many of these make use of standard vehicle equipment such as lights and manipulators, while some require more specialized outfitting with hydrophones and tools. Response techniques tested and evaluated are summarized in table (1).

RESPONSE EFFECT	TECHNIQUE
Warning	Hydrophone Strobe
Disorientation/ Irritation	Strobe Siren
Position Marking	Flood lights Buoy drop
Target Marking	Buoy Tag
Target Capture	Grabber Snare

Table 1: Response Techniques

Preliminary testing indicated that the vehicle was most effective with non-contact means of response. For this reason, the response of testing emphasized response with a stand-off distance: warning, disorientation, and position marking. The Ocean Engineering Enterprises Acoustic Recall System was used for both warning and disorientation, using both the voice and siren modes available. Position marking was accomplished by use of the vehicle lights as described in section 2.3, and by dropping a buoy when the target was intercepted. Means of response involving diver contact including attaching a buoy to the target, and ensnaring the target with a line.

4.0 CURRENT EFFORTS

4.1 Single Operator Control

During the USV demonstrations, a minimum of two system operators were required: one to control the vehicle and one to track the target on the sonar. Once a sonar contact was made, the vehicle operator directed the vehicle based on the sonar operator's instructions. In order to perform in an actual security scenario, it is essential that operation of the vehicle be simplified. Current USV efforts include reducing the load to a single operator by connecting the sonar data and vehicle control system. With this modification, the vehicle operator could designate a given sonar target with the cursor, and the vehicle controls would automatically home in on the location indicated by the

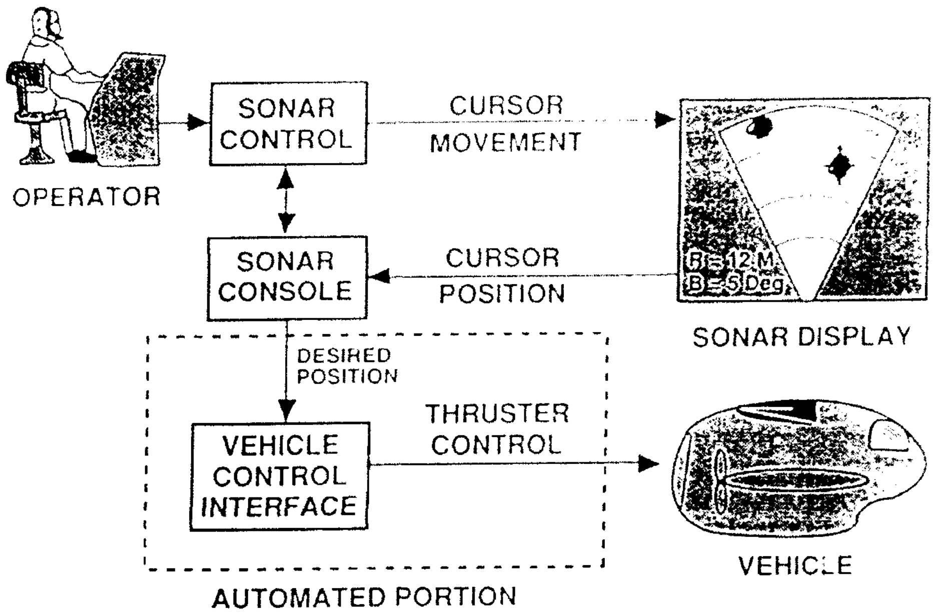

Figure 4: Single Operator Control Concept

cursor (figure 4). This would eliminate the need for separate vehicle and sonar operators, while streamlining the target interception process.

Additional automatic functions could aid in a more efficient operation of the system. Among these are automatic target recognition, alerting, and tracking. If the vehicle is to be used with an external sensor system, its controls could also be tied in with the existing automated features. In this scenario, the external sensor would make the initial contact, and that information would be used by the vehicle to intercept the target. This would provide an excellent foundation for the development of autonomous vehicles, capable of seeking out potential targets independently.

4.2 Operational Considerations

Looking towards actual fleet deployment of a USV/ROVRC system, several operational concerns arise. First is the need for the system to be easily operated with a minimum number of personnel, as discussed above. Secondly, the current USV has no tie-in with existing security systems, posing major integration issues of sensor compatibility and information exchange. Finally, the system must be operable in a timely manner, requiring a rapid launch and recovery system, with particular attention paid to the intended operational platforms. Ideally, the USV would be a complete, easily transportable system, able to be rapidly installed and operated in a variety of security situations.

5.0 CONCLUSION

The USV system has effectively demonstrated the concept of using a vehicle for the assessment of underwater targets. Work in 1992 included the incorporation of an additional sonar, navigation system, and response devices. Current efforts include the integration of sensor and vehicle controls to permit system operation by a single operator. In an operational environment, it would also be necessary to consider the issues of launch and recovery, operator display, and integration with other security systems. With these additions, the USV can become an effective asset, useful for a variety of security applications.